Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Time: 60 mins

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **K/U= /20** | **T/I= /23** | **C= /13** | **A= /13** | **Total = /69** |

**Part A: Knowledge and Understanding**

**True or False, Multiple Choice, Fill in the blank (20 marks)**

**Indicate whether the statement is True (T) or False (F). (Each question is worth 1 mark)**

**1**. When an atom loses an electron during a redox reaction, its oxidation number *increases. \_\_\_\_\_\_\_\_*True*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**2.** When the oxidation number of an atom decreases during a redox reaction, it is acting as a *reducing agent. \_\_\_\_\_\_\_False\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**3.** In all redox reactions, electrons are transferred from *an oxidizing agent to a reducing agent*. \_\_\_\_*\_\_False\_\_\_\_\_\_\_\_\_\_\_\_\_*\_\_\_.

**Circle the correct answer. (Each question is worth 1 mark)**

**4.** For the following reaction which of the following statements is correct?

Pb(s) + 2FeCl3(aq) → 2FeCl2(aq) + PbCl2(aq)

**a.** Lead is oxidized, and iron is reduced.

**b.** Lead is reduced, and iron is oxidized.

**c.** Lead is reduced, and chlorine is oxidized.

**d.** Chlorine is reduced, and iron is oxidized.

**e.** This is not a redox reaction.

**5.** What is the single oxidation number for nitrogen in dinitrogen pentoxide?

**a.** +3 **d.** -3

**b.** +4 **e.** -4

**c.** +5

**6.** Which term is the reverse of a corresponding reduction half-reaction?

**a.** a redox reaction

**b.** a spontaneous reaction

**c.** a non-spontaneous reaction

**d.** a potential reaction

**e.** an oxidation half-reaction

**7.** What is the change in the oxidation number of nitrogen when nitrogen dioxide becomes nitrogen gas in a redox reaction?

**a.** an increase of 4

**b.** a decrease of 4

**c.** an increase of 2

**d.** a decrease of 2

**e.** There is no change to the oxidation number of

nitrogen

**8.** What is a Downs cell?

**a.** a galvanic cell involving zinc and magnesium electrodes

**b.** any cell that requires the use of an inert electrode

**c.** a large cell used for the industrial electrolysis of sodium chloride

**d.** a cell used for the electrolysis of water

**e.** a rechargeable fuel cell

**9.** By definition, an electrolyte is

**a.** a substance that participates in a redox reaction as an ion.

**b.** a spectator ion.

**c.** a reducing agent.

**d.** an oxidizing agent.

**e.** a substance that conducts electricity when dissolved in water.

**10.** The photograph below shows a whole dry cell battery and one that has been cut in half. Why is this type of battery referred to as *dry*?



**a.** It contains no electrolytes.

**b.** The electrolytes have been thickened into a paste.

**c.** Electrolytes have been replaced with conducting wires.

**d.** Electrolytes have been replaced with graphite powder.

**e.** There are no ions present in the cell.

**11.** Which of the following is an example of a fuel cell?

**a.** a galvanic cell

**b.** a dry cell

**c.** a car battery

**d.** a PEM cell

**e.** All of the above are examples of fuel cells.

**12.** For the redox reaction in a galvanic cell shown below, which of the following is the correct notation for the cell?

Pb(s) + 2FeCl3(aq) → 2FeCl2(aq) + PbCl2(aq)

**a.** Pb(s) | Pb2+(aq) || Fe3+(aq) | Fe2+(aq)

**b.** Pb(s) | Pb2+(aq) || Fe3+(aq), Fe2+(aq) | Fe(s)

**c.** Pb(s) | Pb2+(aq) || Fe3+(aq), Fe2+(aq) | Pt(s)

**d.** Fe3+(aq), Fe2+(aq) | Pt(s) || Pb(s) | Pb2+(aq)

**e.** Fe3+(aq), Fe2+(aq) || Pb(s) | Pb2+(aq)

**13.** Which statement is correct with respect to the following redox reaction?

FeO(s) + CO(g) → Fe(ℓ) + CO2(g)

**a.** FeO(s) is the reducing agent, and CO(g) is the oxidizing agent.

**b.** FeO(s) is the oxidizing agent, and CO(g) is the reducing agent.

**c.** FeO(s) is both the oxidizing agent and the reducing agent.

**d.** Fe(ℓ) is the oxidizing agent, and CO2(g) is the reducing agent.

**e.** Fe(ℓ) is the reducing agent, and CO2(g) is the oxidizing agent.

**14**. Which of the following half-reaction equations are balanced?

I. 

II. 

III. 

IV. 

V. 

|  |  |  |  |
| --- | --- | --- | --- |
| **a.** | I and II | **d**. | III and V |
| **b.** | II and IV | **e.** | all are balanced |
| **c.** | I and III |

**Write the answer the questions below in the blank spaces. (Each question is worth 1 mark)**

**15.** Identify the oxidation number of the element underlined in each of the following compounds and write your answer in the space provided.

**a.** K2 SO3 \_\_\_+4\_\_\_\_ **c.** P4O10 \_\_+5\_\_\_

**b.** Mn 2O7 \_\_+7\_\_\_\_ **d.** N2O3 \_\_+3\_\_\_\_

**16**. The number used to express the oxidation state of an element is called the\_\_\_\_\_\_\_\_oxidation number\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**17**.A half- reaction in which electrons are lost is a(n) \_\_\_\_oxidation\_\_\_\_\_half- reaction.

**Part B: Thinking and Inquiry**

**18.** Balance each of the following half-reactions: **(Each question is worth 2 marks)**

**a**.MnO4– (aq) → Mn2+ (aq) (acidic conditions)

**Ans.** 8H+(aq) + MnO4- (aq) + 5e- → Mn2+ (aq) + 4 H2O (l)

**b.** NO3– (aq) → NH4+ (aq) (basic conditions)

**Ans.** NO3-(aq) + 7 H2O(l) + 8e-  → NH4+(aq) + 10 OH-(aq)

**19.** Identify each half-reaction in question 18 as a reduction half-reaction or an oxidation half-reaction.(1 mark each)

**Ans.**

a. Reduction

c. Reduction

**20.** Write the following equation as an ionic equation and then as a net ionic equation. (2 marks)

Cd(s) + Sn(NO3)2(aq) → Cd(NO3)2(aq) + Sn(s)

**Ans.**

Ionic equation: Cd(s) + Sn2+ (aq) +2 NO3-(aq) → Cd2+(aq) + 2 NO3-(aq) + Sn(s)

Net ionic equation: Cd(s) + Sn2+ (aq) → Cd2+(aq) + Sn(s)

**a.** Use the equation to explain the meaning of “spectator ion.” (1 mark)

**b.** Identify the reducing agent.(1 mark)

**c.** Identify the oxidizing agent. (1 mark)

**d.** Which element is oxidized? (1 mark)

**e.** Which element is reduced? (1 mark)

**Ans**

a. In the above equation, NO3-(aq) are spectator ions because they are present in the solution, but do not change during the reaction. (are not involved in the chemical reaction)

b. Cd (s) is the reducing agent

c. Sn2+ (aq) is the oxidising agent

d. Cd (Cadmium) is oxidised

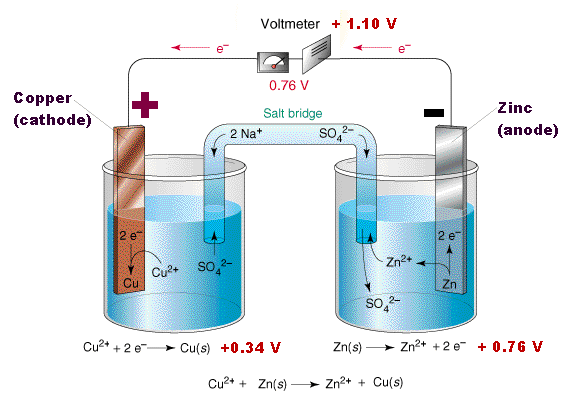
e. Sn (Tin) is reduced

**21.** Consider the following galvanic cell:

Zn(s) | Zn2+ || Cu2+ | Cu

1. Write an equation for the half reaction occurring at the anode **and** cathode. (1 mark)
2. Calculate the standard cell potential. (1 mark)
3. Draw and label the galvanic cell. (2 marks)
4. Identify the anode and the cathode. (0.5 mark)
5. Show the direction of electron flow. (0.5 mark)
6. Show the direction of ion migration through the salt bridge. (1 mark)

**Ans**



**22.** Will a reaction take place if a strip of zinc metal is placed in a solution of lead (II) sulfate? Justify your answer. (4 marks)

**Ans.**

Oxidation half-reaction: Zn(s) →Zn2+ + 2e- oE = +0.76V

Reduction half-reaction: Pb2+(aq) + 2e- → Pb(s) oE = -0.13V

Overall reaction: Zn(s) + Pb2+(aq)→Zn2+ + Pb(s) oE = + 0.63V

The ∆ oE for the overall reaction is positive, therefore a zinc strip will react spontaneously with lead (II) sulfate solution.

**Part C: Application and Communication**

**Answer all the questions in the spaces provided.**

**23.** Outline the similarities and differences between an alkaline battery and a button battery. (4 marks C)(2 similarities and 2 differences are accepted)

**Ans.**

Similarities

Both alkaline and button batteries are dry cells.

Both have alkaline electrolyte paste

Differences

Some alkaline batteries are rechargeable, button batteries are not rechargeable.

Button battery is smaller than an alkaline battery

Structurally different, cathode of the alkaline battery runs along its length inside

Cathode of a button battery is located on the outer surface of the cell.

**24**. Explain the importance of the chlor-alkali process? (3 marks A, 2 marks C)

**Ans.**

Most of the chlorine and sodium hydroxide that are used commercially are produced by the chlor-alkali process.

Sodium hydroxide and chlorine are two of the most extensively produced commercial products in North America.

Chlorine is used to make laundry bleach, to bleach pulp paper, to make compounds for treating water, to use as a disinfectant, and to make hydrochloric acid.

Sodium hydroxide is used in the pulp and paper industry.

Sodium hydroxide is also used to make soaps and detergents, in the production of aluminium and in the manufacturing of many different chemicals.

1. Explain how the hydrogen half-cell is used as a standard reference to determine the voltages of another half-cell. (3 marks C, 2 marks A)

**Ans.**

Standard reduction potentials for all half-cells are measured relative to that of the standard hydrogen half-cell. The reduction potential of the hydrogen ion reduction half-reaction is defined to be exactly zero volts.

2H+(aq) + 2e- 🡪 H2(g) Eor = 0.00 V

As a result, a numerical value can be assigned to the reduction potential associated with every other reaction. The standard reduction potential of a half-cell can be measured by constructing a standard cell using a hydrogen reference half-cell and the half-cell whose reduction potential you want to measure. The magnitude of the voltage (measured with a voltmeter) determines the numerical value of the half-cell potential and the direction of the current determines the sign of the half-cell potential.

**26.** What issues must be solved before the use of hydrogen fuel cell cars could become widespread? (2 marks A, 2 marks C)

**Ans.**

Cost is a major factor, which may be partially solved by mass production.

Obtaining hydrogen gas is another issue. Hydrogen can be produced by electrolysis of water. However, electrolysis of water uses a lot of electrical energy and is an expensive way to obtain hydrogen. Hydrogen gas can also be obtained through reforming of hydrocarbons, which is not an environmentally friendly process as it produces carbon mono and dioxides.

The distribution and storage of hydrogen gas has important safety concerns associated with them as hydrogen is flammable.

**27**. I am looking to buy a new car, and I have narrowed my search to two products; The BMW 645i (approximately $112,000) and the Lada 2110 (approximately $12,000). When looking at the fine print, I notice that BMW offers a 12 year warranty on corrosion while Lada offers a 3 year warranty. Why can BMW, and many other less expensive car companies, offer such an extensive corrosion protection warranty. Explain how BMW’s manufacturing procedure may differ from that of Lada, what different materials may be used, and how the corrosion protection works from an electrochemical standpoint. (6 marks A, 2 marks C)

**Ans.**

One way to protect iron from rusting is to coat it with zinc. Iron so treated is called galvanized iron. Many modern car manufacturers often do a process called zinc electroplating on the entire chassis of the car. As long as the zinc coating is complete, the car will not rust. If the zinc coating is scratched, the zinc will corrode rather than the iron since zinc is a more easily oxidized than iron. Galvanized parts of a car are thus protected from excessive corrosion.

Other manufacturers may choose to paint the car as this is the cheapest and simplest of protecting the metal from corrosion. However, if the paint becomes scratched, the metal underneath can corrode. Other protective layers may include grease or oil, these are cheaper protective methods but they are not as effective as galvanizing.